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ANTICIPATORY SUSTAINED AND ACTION POTENTIALS IN RATS

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In the rat, "slow" or sustained electrical potentials of cerebral cortex (nonrhythmic potentials enduring longer than a half second) accompany responses to reinforcements of the rewarding type (milk or electrical stimulation of the medial forebrain bundle). The cortex acquires sustained potential gradients of negative polarity as subjects learn to anticipate rewards. Called anticipatory potential gradients or APGs, they develop as a function of fixed time intervals between rewards (temporal conditioning) or in relation to cues of upcoming reward (simple conditioning). The slopes of the gradients decrease when the rats are trained to long (30 second) anticipatory intervals and increase when trained to shorter (10 second) intervals. If we present the rewards at irregular intervals during a session the APGs disappear entirely. The rats require certainty in the timing in order to preserve their cerebral cortical APGs.

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Restoration of the APGs to pretrial baselines takes the form of a relative positive shift (subsidence of the negative shift) following the rewards. An absolute positive shift (going

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above the baseline) has been observed when the subject is trained to a cue that informs it that the reward will not appear.

In the last several years we have developed methods to enhance the durability of chronic electrode implantations in the rat (up to 18 months) for both stimulation and recording, to improve the reliability of nonpolarizing and mass unit electrodes for long term recording, to simplify the construction of such electrodes, to advance the amplification technology in the relevant frequency ranges, and to improve the computerization involved in controlling presentation of stimuli and analyzing the electrophysiologic responses. Although many problems were solved, some still remain. Particularly plaguing is the tendency of some nonpolarizing electrodes to intermittently develop high offsets or drift that make them useless, sometimes for weeks. At times they can spontaneously "recover" normally low offsets and give consistent data. Repeated pre-implantation testing of these electrodes in normal saline-agar showed them to be relatively drift free and with low DC offsets over days and, in some cases, weeks. The yield of reliable informative placements is still too low to permit efficient replication across subjects of effects that engage our attention by virtue of a subject being its own control. The latter is shown primarily by the acquisition and change of responses in individual subjects as a function of controlled environmental stimuli.

The effort has been directed toward simultaneous observation of APGs and mass neuronal firings at the same or closely adjacent sites in cortex and, in one or two cases, of hippocampus. In many instances the expected increment in neuronal firing rates with negatively directed APGs has been confirmed. But we have also seen many cases of "paradoxical" decrements in neuronal firing under the same experimental conditions. We have ruled out artifactual sources for this phenomenon.

Of the 33 chronic preparations attempted in the last 3 years, 15 yielded data over 1 or more months of training. The patterns of APG and mass unit responding under a variety of training schedules are too complex to permit easy generalization and they must be further analyzed to be summarized in any meaningful way. The electrode placements have been confined largely to visual cortex for technical convenience in mounting 12 electrodes per preparation. A variety of combinations of polarizing and nonpolarizing, cortical surface and depth electrodes for tracking sustained potentials and multiple unit firing potentials were undertaken. We were unable to reach a hoped for stage of comparing massed unit activity during demonstration of absolute positivity in APGs during specific cued expectancy of nonreinforcement.

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